Whole-body absorption in heterogeneous adult and child human body model in realistic environments

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ABSTRACT

In order to protect the public against adverse health effects of radio-frequency electromagnetic radiation, ICNIRP has issued guidelines limiting the exposure in terms of incident root-mean-square (rms) field strengths by reference levels and in terms of absorption by basic restrictions. The reference levels on the incident fields are derived from the basic restrictions using spheroidal homogeneous phantoms exposed to a worst-case horizontally incident plane wave. However, single plane-wave exposure never occurs in a realistic environment. The exposure in a realistic environment is heterogeneous due to reflections, refractions, and transmissions of propagating waves in the environment and is time-varying. Hence, the assessment of the absorption in such a realistic environment based on the measured field levels is a very difficult and complex task. Moreover, the RF absorption in a human body depends on the external and internal morphology, such as size, posture, and dielectric properties. Hence, assessing the absorption requires a stochastical approach investigating thousands of exposure samples.

In this study an in-house developed statistical exposure tool is used to assess the whole-body absorption (SAR_{wb}) in an adult and a child human body model. We selected the Virtual Family Male (VFM) for the adult model and the six-year old Virtual Family Boy. Both human body models are exposed to the GSM downlink at 950 MHz in five different environments, i.e., rural, urban-macrocell, urban-microcell, indoor-outdoor, and indoor-picocell. Both, incident fields and the whole-body absorption are determined for 4000 exposure samples in every environment. The rms incident field strengths are averaged as specified by ICNIRP (averaging over the volume of the human body) and CENELEC (averaging in a plane of 40 cm by 70 cm). It is shown that SAR_{wb} for worst-case single plane wave exposure is exceeded in about 4 % of the exposure samples in a multipath exposure environment. Furthermore, it is also shown that ICNIRP basic restrictions are unlikely to be exceeded at 950 MHz in a realistic exposure environment for the VFB.